CLAIMS

1. A method of preparing a multilayer electric current producing cell, said cell comprising a casing and a prismatic cell stack, said prismatic cell stack having an external length dimension, an external width dimension, an external thickness dimension, two substantially parallel flat surfaces, and outside permeable surfaces; which method comprises, in order, the steps of:

(a) providing a laminar combination of:

(i) an anode comprising an anode active layer, which layer comprises an anode active material comprising lithium;

(ii) a solid composite cathode comprising a cathode active layer, which layer comprises a cathode active material, said cathode active layer having a first surface and a second opposite surface, said solid composite cathode further comprising a non-permeable current collector in contact with said first surface of said cathode active layer; and,

(iii) a separator interposed between said anode and said solid composite cathode, and in contact with said second surface of said cathode active layer;

wherein said anode active layer and said cathode active layer are positioned in a face-to-face relationship;

(b) winding said combination on a mandrel having a cross-section of a rounded shape and having a circumference selected from the lengths consisting of:

(i) 140 to 200 per cent of the difference between said external length dimension and said external thickness dimension of said prismatic cell stack; and,

(ii) 140 to 200 per cent of the difference between said external width dimension and said external thickness dimension of said prismatic cell stack;

said winding forming a rounded anode-separator-solid composite cathode subassembly having a jellyroll configuration and a rounded shape;

(c) removing said mandrel from said rounded subassembly;

(d) compressing said rounded subassembly in a press to form a prismatic subassembly having two substantially parallel flat surfaces;

(e) removing said prismatic subassembly from said press;

(f) contacting said prismatic subassembly with a source of a liquid nonaqueous lithium salt electrolyte to form said prismatic cell stack, wherein said electrolyte substantially fills porous areas within said prismatic cell stack;

(g) removing said prismatic cell stack from contact with said source of electrolyte;

(h) enclosing said prismatic cell stack in a barrier material film; and,

(i) sealing said film to form said casing.

2. The method of claim 1, wherein, after step (c) and prior to step (d), said rounded subassembly is shaped into a form that is intermediate between said rounded shape resulting from step (c) and a prismatic shape having two substantially parallel flat surfaces.

3. The method of claim 2, wherein said intermediate form comprises a prefolded edge.

4. The method of claim 1, wherein, prior to step (b), one or more anode tabs are attached to said anode and one or more cathode tabs are attached to said current collector of said solid composite cathode.

5. The method of claim 4, wherein, after step (c) and prior to step (d), said rounded subassembly is shaped into a form that is intermediate between said rounded shape resulting from step (c) and a prismatic shape having two substantially parallel flat surfaces.

6. The method of claim 5, wherein said intermediate form comprises a prefolded edge.

7. The method of claim 1, wherein, after step (c) and prior to step (d), one or more anode tabs are attached to said anode and one or more cathode tabs are attached to said current collector of said solid composite cathode.

8. The method of claim 1, wherein, after step (e) and prior to step (f), one or more anode tabs are attached to said anode and one or more cathode tabs are attached to said current collector of said solid composite cathode.

9. The method according to any one of claims 4 to 8, wherein said one or more anode tabs and said one or more cathode tabs extend from said prismatic cell stack and through said casing in an electrically insulated relationship with respect to each other and to said casing.

10. The method of claim 1, wherein, after step (g) and prior to step (h), said outside permeable surfaces of said prismatic cell stack are encapsulated to form a non-permeable prismatic cell stack.

11. The method of claim 10, wherein said outside permeable surfaces are:

(i) immersed in a liquid comprising an encapsulating resin;

(ii) removed from said liquid; and,

(iii) heated or cooled to form a non-permeable layer of said encapsulating resin over said outside permeable surfaces of said prismatic cell stack.

12. The method of claim 1, wherein said rounded subassembly has an outermost layer formed by said separator.

13. The method of claim 1, wherein, after step (b) and prior to step (d), said rounded subassembly is wound with a layer of an insulating film, and said film is attached to said rounded subassembly.

14. The method of claim 1, wherein said rounded shape in step (b) is a circle.

15. The method of claim 1, wherein said rounded shape in step (b) is an ellipse.

16. The method of claim 1, wherein said circumference is selected from the lengths consisting of:

(i) 150 to 195 per cent of the difference between said external length dimension and said external thickness dimension of said prismatic cell stack; and,

(ii) 150 to 195 per cent of the difference between said external width dimension and said external thickness dimension of said prismatic cell stack.

17. The method of claim 1, wherein said circumference is selected from the lengths consisting of:

(i) 160 to 190 per cent of the difference between said external length dimension and said external thickness dimension of said prismatic cell stack; and,

(ii) 160 to 190 per cent of the difference between said external width dimension and said external thickness dimension of said prismatic cell stack.

18. The method of claim 1, wherein said anode active layer is a lithium metal layer.

19. The method of claim 18, wherein, after step (e) and prior to step (f), one or more anode tabs are attached to said lithium metal of said anode active layer and one or more cathode tabs are attached to said current collector of said solid composite cathode.

20. The method of claim 18, wherein an edge of said lithium metal layer extends beyond corresponding edges of said solid composite cathode and said separator to form a lithium metal extension, and wherein substantially all of said lithium metal extensions are placed in electrical contact by ultrasonic welding.

21. The method of claim 1, wherein said anode further comprises a non-permeable current collector.

22. The method of claim 21, wherein, prior to step (b), one or more anode tabs are attached to said non-permeable current collector of said anode and one or more cathode tabs are attached to said current collector of said solid composite cathode.

23. The method of claim 21, wherein said non-permeable current collector of said anode comprises a conductive layer having a first surface and an opposite second surface, said first surface being in contact with said anode active layer, wherein said conductive layer is selected from the group consisting of:

conductive metals, coatings comprising conductive metal pigments, coatings comprising conductive carbons, coatings comprising conductive graphites, and coatings comprising conductive metal oxide pigments.

24. The method of claim 23, wherein said second surface of said conductive layer of said non-permeable current collector of said anode is in contact with an insulating layer.

25. The method of claim 23, wherein an edge of said conductive layer of said non-permeable current collector of said anode provides a plurality of anode contact edges for said multilayer cell; and wherein a metallic layer is deposited in electrical contact with said conductive layers at substantially all of said anode contact edges.

26. The method of claim 25, wherein said edge of said conductive layer of said non-permeable current collector of said anode extends beyond corresponding edges of said solid composite cathode, said separator, and said anode active layer.

27. The method of claim 25, wherein said metallic layer comprises a metal selected from the group of metals consisting of: copper and nickel.

28. The method of claim 25, wherein said metallic layer is deposited by metal spraying.

29. The method of claim 24, wherein said conductive layer of said non-permeable current collector of said anode comprises copper, and said insulating layer of said non-permeable current collector of said anode is selected from the group consisting of: plastic films and polymeric coatings.

30. The method of claim 1, wherein said non-permeable current collector of said solid composite cathode is selected from the group consisting of: conductive metal foils and conductive metal layers on an insulating layer.

31. The method of claim 30, wherein a conductive layer is interposed between said cathode active layer and said non-permeable current collector of said solid composite cathode, which conductive layer is selected from the group consisting of:

coatings comprising conductive metal pigments, coatings comprising conductive carbons, coatings comprising conductive graphites, and coatings comprising conductive metal oxide pigments.

32. The method of claim 30, wherein said conductive metal of said non-permeable current collector of said solid composite cathode comprises aluminum, and said insulating layer of said non-permeable current collector of said solid composite cathode is selected from the group consisting of: plastic films and polymeric coatings.

33. The method of claim 30, wherein an edge of said conductive metal foil of said current collector of said solid composite cathode extends beyond corresponding edges of said anode and said separator to form a conductive metal foil extension, and wherein substantially all of said conductive metal foil extensions are placed in electrical contact by ultrasonic welding.

34. The method of claim 30, wherein an edge of said current collector of said solid composite cathode provides a plurality of cathode contact edges for said multilayer cell; and wherein a metallic layer is deposited in electrical contact with said current collector of said solid composite cathode at substantially all of said cathode contact edges.

35. The method of claim 34, wherein said edge of said current collector of said solid composite cathode extends beyond corresponding edges of said cathode active layer, said separator, and said anode.

36. The method of claim 34, wherein said metallic layer comprises a metal selected from the group consisting of: aluminum, nickel, silver, tin, and stainless steel.

37. The method of claim 34, wherein said metallic layer is deposited by metal spraying.

38. The method of claim 30, wherein said anode further comprises a non-permeable current collector, said current collector of said anode comprising a conductive layer having a first surface and an opposite second surface, said first surface being in contact with said anode active layer;

wherein said second surface of said conductive layer of said non-permeable current collector of said anode is in contact with an insulating layer;

and further wherein said conductive layer of said non-permeable current collector of said anode is selected from the group consisting of:

conductive metals, coatings comprising conductive metal pigments, coatings comprising conductive carbons, coatings comprising conductive graphites, and coatings comprising conductive metal oxide pigments.

39. The method of claim 38, wherein said insulating layer of said current collector of said anode and said insulating layer of said current collector of said solid composite cathode are positioned in a face-to-face relationship.

40. The method of claim 39, wherein said insulating layers positioned in said face-to-face relationship are adhered to each other.

41. The method of claim 40, wherein said insulating layers are adhered to each other by the application of heat.

42. The method of claim 41, wherein said heat is applied during step (b).

43. The method of claim 41, wherein said heat is applied during step (d).

44. The method of claim 40, wherein, prior to step (b), said insulating layers are adhered to each other by application of an adhesive to one or both of said insulating layers.

45. The method of claim 1, wherein said separator is a porous polyolefin separator.

46. The method of claim 1, wherein said separator comprises a microporous pseudo-boehmite layer.

47. The method of claim 1, wherein said separator is coated on said solid composite cathode.

48. The method of claim 47, wherein said separator comprises a microporous pseudo-boehmite layer.

49. The method of claim 1, wherein said press is operated at a pressure in the range of 100 to 6000 kPa to form said prismatic subassembly.

50. The method of claim 1, wherein said press is operated at a pressure in the range of 200 to 5000 kPa to form said prismatic subassembly.

51. The method of claim 1, wherein said press is operated at a pressure in the range of 200 to 3500 kPa to form said prismatic subassembly.

52. The method of claim 1, wherein said press contacts said rounded subassembly via a metal surface.

53. The method of claim 1, wherein said press contacts said rounded subassembly via a rubber surface.

54. The method of claim 1, wherein said contacting of said prismatic subassembly in step (f) is performed utilizing a vacuum backfill procedure comprising the steps of:

    (i) placing said prismatic subassembly in a container;

    (ii) subjecting said container to a vacuum for a specific time;

    (iii) contacting said prismatic subassembly with said electrolyte; and,

    (iv) continuing contacting of said prismatic subassembly for a total time period.

55. The method of claim 1, wherein, in step (f), said prismatic subassembly is contacted with said electrolyte source for a total time period in the range of 0.01 to 50 hours.

56. The method of claim 1, wherein, in step (f), said prismatic subassembly is contacted with said electrolyte source for a total time period in the range of 0.02 to 25 hours.

57. The method of claim 1, wherein, in step (f), said prismatic subassembly is contacted with said electrolyte source for a total time period in the range of 0.02 to 2 hours.

58. The method of claim 1, wherein, during step (f), said prismatic subassembly is placed in a fixture to maintain said two substantially parallel flat surfaces, and said fixture is removed prior to step (h).

59. The method of claim 1, wherein, during step (f), a strip of material is wound around a circumference of said prismatic subassembly to maintain said two substantially parallel flat surfaces.

60. The method of claim 59, wherein said strip is removed prior to step (h).

61. The method of claim 1, wherein, after step (g) and prior to step (h), excess electrolyte on outside surfaces of said prismatic cell stack is substantially removed.

62. The method of claim 1, wherein said anode active material comprising lithium is selected from the group consisting of:

lithium metal, lithium-aluminum alloys, lithium-tin alloys, lithium-intercalated carbons, lithium-intercalated graphites, lithium doped polyacetylenes, lithium doped polyphenylenes, and lithium doped polypyrroles.

63. The method of claim 1, wherein said cathode active layer comprises greater than 50 per cent by weight of a sulfur-containing cathode active material, and said cathode active layer has a porosity in the range of 20 to 75 per cent by volume.

64. The method of claim 1, wherein said cathode active material in said cathode active layer comprises elemental sulfur.

65. The method of claim 1, wherein said cathode active material in said cathode active layer comprises a sulfur-containing polymer comprising $-S_m-$ moieties, wherein m is an integer equal to or greater than 3.

66. A method of preparing a multilayer electric current producing cell, said cell comprising a casing and a prismatic cell stack, said prismatic cell stack having an external length dimension, an external width dimension, an external thickness dimension, two substantially parallel flat surfaces, and outside permeable surfaces; which method comprises, in order, the steps of:

(a) providing a laminar combination of:

(i) an anode comprising an anode active layer, which layer comprises an anode active material comprising lithium;

(ii) a solid composite cathode comprising a cathode active layer, which layer comprises a cathode active material, said cathode active layer having a first surface and a second opposite surface, said solid composite cathode further comprising a non-permeable current collector in contact with said first surface of said cathode active layer; and,

(iii) a separator interposed between said anode and said solid composite cathode, and in contact with said second surface of said cathode active layer;

wherein said anode active layer and said cathode active layer are positioned in a face-to-face relationship;

(b) winding said combination on a mandrel having a cross-section of a rounded shape and having a circumference selected from the lengths consisting of:

(i) 140 to 200 per cent of the difference between said external length dimension and said external thickness dimension of said prismatic cell stack; and,

(ii) 140 to 200 per cent of the difference between said external width dimension and said external thickness dimension of said prismatic cell stack;

said winding forming a rounded anode-separator-solid composite cathode subassembly having a jellyroll configuration and a rounded shape;

(c) removing said mandrel from said rounded subassembly;

(d) contacting said rounded subassembly with a source of liquid nonaqueous lithium salt electrolyte to form a rounded cell stack, wherein said electrolyte substantially fills porous areas within said rounded cell stack;

(e) compressing said rounded cell stack in a press to form said prismatic cell stack, wherein said electrolyte substantially fills porous areas within said prismatic cell stack;

(f) removing said prismatic cell stack from said press;

(g) enclosing said prismatic cell stack in a barrier material film; and,

(h) sealing said film to form said casing.

67. The method of claim 66, wherein after step (c)and prior to step (d) said rounded subassembly is shaped into a form that is intermediate between said rounded shape resulting from step (c) and a prismatic shape having two substantially parallel flat surfaces.

68. The method of claim 66, wherein prior to step (b), one or more anode tabs are attached to said anode and one or more cathode tabs are attached to said current collector of said solid composite cathode.

69. The method of claim 68, wherein said one or more anode tabs and said one or more cathode tabs extend from said prismatic cell stack and through said casing in an electrically insulated relationship with respect to each other and to said casing.

70. The method of claim 69, wherein after step (f) and prior to step (g), said outside permeable surfaces of said prismatic cell stack are encapsulated to form a non-permeable prismatic cell stack.

71. The method of claim 70, wherein said outside permeable surfaces are:

(i) immersed in a liquid comprising an encapsulating resin;

(ii) removed from said liquid; and,

(iii) heated or cooled to form a non-permeable layer of said encapsulating resin over said outside permeable surfaces of said prismatic cell stack.

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72. The method of claim 66, wherein said anode further comprises a non-permeable current collector.

73. The method of claim 72, wherein prior to step (b), one or more anode tabs are attached to said non-permeable current collector of said anode and one or more cathode tabs are attached to said current collector of said solid composite cathode.

74. The method of claim 72, wherein said non-permeable current collector of said anode comprises a conductive layer having a first surface and an opposite second surface, said first surface being in contact with said anode active layer, wherein said conductive layer is selected from the group consisting of:

conductive metals, coatings comprising conductive metal pigments, coatings comprising conductive carbons, coatings comprising conductive graphites, and coatings comprising conductive metal oxide pigments.

75. The method of claim 74, wherein said second surface of conductive layer is in contact with an insulating layer of said non-permeable current collector of said anode.

76. The method of claim 66, wherein said non-permeable current collector of said solid composite cathode is selected from the group consisting of: conductive metal foils and conductive metal layers on an insulating layer.

77. The method of claim 76, wherein a conductive layer is interposed between said cathode active layer and said non-permeable current collector of said solid composite cathode, which conductive layer is selected from the group consisting of:

coatings comprising conductive metal pigments, coatings comprising conductive carbons, coatings comprising conductive graphites, and coatings comprising conductive metal oxide pigments.

78. The method of claim 76, wherein said conductive metal of said non-permeable current collector of said solid composite cathode comprises aluminum, and said insulating layer of said non-permeable current collector of said solid composite cathode is selected from the group consisting of: plastic films and polymeric coatings.

79. The method of claim 76, wherein said anode further comprises a non-permeable current collector, which non-permeable current collector of said anode comprises a conductive layer having a first surface and an opposite second surface, said first surface being in contact with said anode active layer and said second surface of said conductive layer of said non-permeable current collector of said anode being in contact with an insulating layer; wherein said conductive layer is selected from the group consisting of:

conductive metals, coatings comprising conductive metal pigments, coatings comprising conductive carbons, coatings comprising conductive graphites, and coatings comprising conductive metal oxide pigments.

80. The method of claim 79, wherein said insulating layer of said current collector of said anode and said insulating layer of said current collector of said solid composite cathode are positioned in a face-to-face relationship.

81. The method of claim 80, wherein said insulating layers positioned in said face-to-face relationship are adhered to each other.

82. The method of claim 81, wherein said insulating layers are adhered to each other by application of heat.

83. The method of claim 82, wherein said heat is applied during step (b).

84. The method of claim 80, wherein prior to step (b), said insulating layers are adhered to each other by application of an adhesive to one or both of said insulating layers.

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85. The method of claim 66, wherein said separator is a porous polyolefin separator.

86. The method of claim 66, wherein said separator comprises a microporous pseudo-boehmite layer.

87. The method of claim 66, wherein said separator is coated on said solid composite cathode.

88. The method of claim 87, wherein said separator comprises a microporous pseudo-boehmite layer.

89. The method of claim 66, wherein said press is operated at a pressure in the range of 100 to 6000 KPa to form said prismatic cell stack.

90. The method of claim 66, wherein said press is operated at a pressure in the range of 200 to 5000 KPa to form said prismatic cell stack.

91. The method of claim 66, wherein said press is operated at a pressure in the range of 200 to 3500 KPa to form said prismatic cell stack.

92. The method of claim 66, wherein said press contacts said rounded subassembly via a metal.

93. The method of claim 66, wherein said press contacts said rounded subassembly via a rubber material.

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94. The method of claim 66, wherein said contacting of said rounded subassembly in step (d) is performed utilizing a vacuum backfill procedure comprising the steps of (i) placing said rounded subassembly in a container; (ii) subjecting said container to a vacuum for a specific time; (iii) contacting said rounded subassembly with said electrolyte and, (iv) continuing contacting of said rounded subassembly for a total time period.

95. The method of claim 66, wherein in step (d) of said rounded subassembly is contacted with said electrolyte source for a total time period in the range of 0.01 to 50 hours.

96. The method of claim 66, wherein in step (d) of said rounded subassembly is contacted with said electrolyte source for a total time period in the range of 0.02 to 25 hours.

97. The method of claim 66, wherein in step (d) of said rounded subassembly is contacted with said electrolyte source for a total time period in the range of 0.02 to 2 hours.

98. The method of claim 66, wherein, after step (f) and prior to step (g), excess electrolyte on outside surfaces of said prismatic cell stack is substantially removed.

99. The method of claim 66, wherein said cathode active layer comprises greater than 50 per cent by weight of a sulfur-containing cathode active material, and said cathode active layer has a porosity in the range of 20 to 75 per cent by volume.

100. The method of claim 66, wherein said cathode active material in said cathode active layer comprises elemental sulfur.

101. The method of claim 66, wherein the cathode active material in said cathode active layer comprises a sulfur-containing polymer comprising $-S_m-$ moieties, wherein m is an integer equal to or greater than 3.

102. The method of claim 66, wherein said anode active material comprising lithium is selected from the group consisting of:

lithium metal, lithium-aluminum alloys, lithium-tin alloys, lithium-intercalated carbons, lithium-intercalated graphites, lithium doped polyacetylenes, lithium doped polyphenylenes, and lithium doped polypyrroles.

103. The method of claim 66, wherein said anode active layer is a lithium metal layer.

~~104. An electric current producing cell, wherein said cell is prepared according to the method of claim 1.~~

~~105. An electric current producing cell, wherein said cell is prepared according to the method of claim 66.~~